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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

October 1969 United States Training and Employment Service Technical Report S-445

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Development of USTES Aptitude Test Battery

for

Machinery Erector

(engine & turbine; mach. mfg.) 638.281

TM 002 057

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MANPOWER ADMINISTRATION

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Technical Report on Development of USTES Aptitude Test Battery

For . . . . . .

Machinery Erector (engine & turbine; mach. mfg.) 638.281

S-445

(Developed in Cooperation with the
Ohio State Employment Service)

U. S. Department of Labor
Manpower Administration

October 1969

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study # 2772

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

FOR

Machinery Erector (engine & turbine; mach. mfg.) 638.281-014

S-445

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Heavy Machinery Erector. The following norms were established.

GATB Aptitudes	Minimum Acceptable GATB Scores
N - Numerical Aptitude	75
S - Spatial Aptitude	90
M - Manual Dexterity	75

RESEARCH SUMMARY

Sample:

55 male workers employed as Heavy Machinery Erectors at ABEX Corporation, Denison Division, Columbus, Ohio; Independent Machine Company, Cuyahoga Falls, Ohio; Jeffrey Manufacturing Company, Columbus, Ohio; and Vaughn Machinery Company, Cuyahoga Falls, Ohio. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group composition is unknown.

Criterion:

Supervisory ratings

Design:

Concurrent (test data were collected from January 19, 1968, through March 19, 1968, and criterion data were collected approximately the same time.)

Minimum aptitude requirements were determined on the basis of a job analysis, and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations, and selective efficiencies.

Concurrent Validity:

Phi Coefficient = .32 ($P < .01$)

Effectiveness of Norms:

Only 64% of the non-test-selected workers used for this study were proficient workers; if the workers had been test-selected with the above norms, 76% would have been proficient workers. 36% of the non-test-selected workers used for this study were less proficient workers; if the workers had been test-selected with the above norms, only 24% would have been less proficient workers. The effectiveness of the norms is shown graphically in Table I:

TABLE I

Effectiveness of Norms

	Without Tests	With Tests
Proficient Workers	64%	76%
Less Proficient Workers	36%	24%

VALIDATION SAMPLE DESCRIPTION

Size:

N - 55

Occupational Status:

Employed workers

Work Setting:

Workers were employed at ABEX Corporation, Denison Division, Columbus, Ohio; Independent Machine Company, Cuyahoga Falls, Ohio; Jeffrey Manufacturing Company, Columbus, Ohio; and Vaughn Machinery Company, Cuyahoga Falls, Ohio.

Employer Selection Requirements:

Workers for this job were selected from existing plant personnel. No hiring is done directly for the job. In most cases workers in this occupation work in two-man teams.

Education: No requirement

Experience: Prior factory experience.

Tests: None

Other: Personal interview; physical examination on entry; sex, male.

Principal Activities:

The job duties for each worker are those shown in the job description on the Fact Sheet.

Minimum Experience:

All workers had completed 12 months on-the-job-training before they were tested.

TABLE 2

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age and Education

	Mean	SD	Range	r
Age (years)	39.2	11.7	19-62	-0.030
Education (years)	11.2	1.5	7-14	0.062
Experience (months)	125.1	98.4	13-381	0.228

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B, were administered to the validation sample during the period January 19, 1968, through March 19, 1968.

CRITERION

The criterion data consisted of supervisors' ratings of job proficiency collected two weeks and again one month after the workers were tested.

Rating Scale:

A special rating scale was developed for this study. The scale (see Appendix) included nine items of USTES Form SP-21, Descriptive Rating Scale, and seven items developed to measure performance on specific aspects of the job identified by the job analyst and other experts in the field as being important. The scale contained sixteen items covering different aspects of job performance with five alternative levels of performance for each.

Reliability:

A reliability coefficient of .88 was obtained between the two ratings. Therefore, the combined score of the two ratings was used as the criterion.

Criterion Score Distribution:

Possible Range:	32-160
Actual Range	62-157
Mean:	110.1
Standard Deviation:	22.0

Criterion Dichotomy:

The criterion distribution was dichotomized into high and low groups by placing 36% of the sample in the low group and 64% into the high criterion group to correspond with the percentage of workers considered to be the less proficient workers. Workers in the high criterion group were designated as "proficient workers" and those in the low criterion group as "less proficient workers." The criterion critical score is 101.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes G and N were considered for inclusion in the trial norms because there was a significant correlation with the criterion. Aptitudes S and M were considered because they had a relatively high mean and were judged to be important by job analysis. Aptitude Q, which did not have a significant correlation with the criterion, was also considered for inclusion in the norms because the sample had a relatively high mean and a relatively low standard deviation on this aptitude. With employed workers a relatively high mean and low standard deviation may indicate some sample pre-selection. Tables 3, 4, and 5, show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis

(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Required for studying blueprints and understanding assembly instructions.
S - Spatial Aptitude	Required for ability to visualize blueprints three dimensionally for erection and adjustment of machines.
P - Form Perception	Required in the positioning and fitting of various machine parts.
M - Manual Dexterity	Required for handling, manipulating, and assembling parts, tools, and equipment.

TABLE 4

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB (N=55)

	Mean	SD	Range	r
G - General Learning Ability	97.5	13.6	67-125	.298*
V - Verbal Aptitude	94.5	11.4	72-115	.184
N - Numerical Aptitude	93.2	15.7	57-130	.299*
S - Spatial Aptitude	102.9	18.8	65-137	.171
P - Form Perception	96.0	19.1	54-148	.140
Q - Clerical Perception	98.7	11.9	72-126	.225
K - Motor Coordination	88.4	17.0	43-124	.074
F - Finger Dexterity	93.8	21.3	36-144	.131
M - Manual Dexterity	99.9	18.8	47-141	.188

* Significant at the .05 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X			X	X				X
Irrelevant									
Relatively High Mean				X		X			X
Relatively Low Standard Deviation	X	X				X			
Significant Correlation with Criterion	X		X						
Aptitudes to be Considered for Trial Norms	G		N	S		Q			M

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of G, N, S, Q, and M at trial cutting scores were able to differentiate between 64% of the sample considered proficient workers and 36% of the sample considered less proficient workers. Trial cutting scores at five point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, cutting scores of slightly higher than one standard deviation below the mean will eliminate about one-third of the sample. And for four-aptitude trial norms, cutting scores for slightly less than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of N-75, S-90. and M-75 provided optimum differentiation for the occupation of **Machinery Erector (engine & turbine; mach. mfg.) 638.281-014. The** validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .32 (statistically significant at the .01 level).

TABLE 6

Concurrent Validity of Test Norms
N-75, S-90, and M-75

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Proficient Workers	7	28	35
Less Proficient Workers	11	9	20
Total	18	37	55

Phi Coefficient (ϕ) = .32
Significant Level = $P/2 < .01$

Chi Square (X^2_y) = 5.6

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-25, which is shown in Section II of the Manual for the General Aptitude Test Battery. A Phi Coefficient of .22 was obtained with the OAP-32 norms of N-80, S-90, and M-80.

SP-21

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

Score_____

RATING SCALE FOR HEAVY MACHINERY ERECTOR 638.281-014
D. O. T. Title and Code

Directions: Please read the sheet "Suggestions to Raters" and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of worker (print) _____
(Last) (First)

Sex: Male _____ Female _____

Company Job Title: _____

How often do you see this worker in a work situation?

☐ See him at work all the time.

☐ See him at work several times a day.

☐ See him at work several times a week.

☐ Seldom see him in work situation.

How long have you worked with him?

☐ Under one month.

☐ One to two months.

☐ Three to five months.

☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.

☐ 2. Capable of low work output. Can perform at a slow pace.

☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.

☐ 4. Capable of high work output. Can perform at a fast pace.

☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

☐ 1. Very poor. Does work of unsatisfactory grade. Performance is inferior and almost never meets minimum quality standards.

☐ 2. Not too bad, but the grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.

☐ 3. Fair. The grade of his work is mediocre. Performance is acceptable but usually not superior in quality.

☐ 4. Good, but the grade of his work is not outstanding. Performance is usually superior in quality.

☐ 5. Very good. Does work of outstanding grade. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

☐ 1. Very inaccurate. Makes very many mistakes. Work needs constant checking.

☐ 2. Inaccurate. Makes frequent mistakes. Work needs more checking than is desirable.

☐ 3. Fairly accurate. Makes mistakes occasionally. Work needs only normal checking.

☐ 4. Accurate. Makes few mistakes. Work seldom needs checking.

☐ 5. Highly accurate. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.

☐ 2. Has little knowledge. Knows enough to "get by."

☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.

☐ 4. Has broad knowledge. Knows enough to do good work.

☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

☐ 1. Very low aptitude. Has great difficulty doing his job. Not at all suited to this kind of work.

☐ 2. Low aptitude. Usually has some difficulty doing his job. Not too well suited to this kind of work.

☐ 3. Moderate aptitude. Does his job without too much difficulty. Fairly well suited to this kind of work.

☐ 4. High aptitude. Usually does his job without difficulty. Well suited to this kind of work.

☐ 5. Very high aptitude. Does his job with great ease. Unusually well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

☐ 1. A very limited variety. Cannot perform different operations adequately.

☐ 2. A small variety. Can perform few different operations efficiently.

☐ 3. A moderate variety. Can perform some different operations with reasonable efficiency.

☐ 4. A large variety. Can perform several different operations efficiently.

☐ 5. An unusually large variety. Can do very many different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

☐ 1. Very unresourceful. Almost never is able to figure out what to do. Needs help on even minor problems.

☐ 2. Unresourceful. Often has difficulty handling new situations. Needs help on all but simple problems.

☐ 3. Fairly resourceful. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.

☐ 4. Resourceful. Usually able to handle new situations. Needs help on only complex problems.

☐ 5. Very resourceful. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How often does he make practical suggestions for doing things in better ways? (Worker's ability to improve work methods.)

☐ 1. Never. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.

☐ 2. Very seldom. Slow to see new ways to improve methods. Contributes few practical suggestions.

☐ 3. Once in a while. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.

☐ 4. Frequently. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.

☐ 5. Very often. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and <u>only</u> these factors, how satisfactory is his work? (Worker's "all-around" ability to do his job.)

☐ 1. Definitely unsatisfactory. Would be better off without him. Performance usually not acceptable.

☐ 2. Not completely satisfactory. Of limited value to the organization. Performance somewhat inferior.

☐ 3. Satisfactory. A fairly proficient worker. Performance generally acceptable.

☐ 4. Good. A valuable worker. Performance usually superior.

☐ 5. Outstanding. An unusually competent worker. Performance almost always top notch.

SPECIAL RATING SCALE

J. How well can he read blueprints? (Worker's ability to fully and completely use blueprints to maintain efficient output. More than just "getting by" as a blueprint reader.)

- ☐ 1. Capable of outstanding performance in this respect. Probably falls within the top ten per cent of all persons doing this type of work.
- ☐ 2. Performs at an above average level. Could be considered as being in the upper third of all workers in this occupation.
- ☐ 3. Usual performance is at a satisfactory level. In this respect, probably falls somewhere near the average of all persons doing this kind of work.
- ☐ 4. Shows somewhat limited capabilities in this aspect of the job. Could be considered as being in the lower third of all workers in this occupation.
- ☐ 5. Has demonstrated very definite limitations in this respect. Performance is probably similar to that of the lower ten per cent of all persons doing this work.

K. How accurate is he in his assemblies? (How much checking is required of his work? How much re-working is required to make his work acceptable?)

- ☐ 1. Capable of outstanding performance in this respect.
- ☐ 2. Performs at an above average level.
- ☐ 3. Usual performance is at a satisfactory level.
- ☐ 4. Shows somewhat limited capabilities in this aspect of the job.
- ☐ 5. Has demonstrated very definite limitations in this respect.

L. Does he skip any steps in assembly procedure? (Worker's ability to follow correct procedure such as oiling and greasing or bolt-tighting so as to keep machine free free from damage due to negligence from omitting a proper step.)

- ☐ 1. Capable of outstanding performance in this respect.
- ☐ 2. Performs at an above average level.
- ☐ 3. Usual performance is at a satisfactory level.
- ☐ 4. Shows somewhat limited capabilities in this aspect of the job.
- ☐ 5. Has demonstrated very definite limitations in this respect.

M. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation. Ability to solve new problems using his own imagination.)

- ☐ 1. Capable of outstanding performance in this respect.
- ☐ 2. Performs at an above average level.
- ☐ 3. Usual performance is at a satisfactory level.
- ☐ 4. Shows somewhat limited capabilities in this aspect of the job.
- ☐ 5. Has demonstrated very definite limitations in this respect.

N. How much does he know about assembly work? (Worker's understanding of the principles, equipment, materials and methods that have to do with his work.)

- ☐ 1. Capable of outstanding performance in this respect.
- ☐ 2. Performs at an above average level.
- ☐ 3. Usual performance is at a satisfactory level.
- ☐ 4. Shows somewhat limited capabilities in this aspect of the job.
- ☐ 5. Has demonstrated very definite limitations in this respect.

O. Is he a good team worker? (Worker's ability to work closely with a partner in harmony. The ability to get cooperation and to cooperate.)

- ☐ 1. Capable of outstanding performance in this respect.
- ☐ 2. Performs at an above average level.
- ☐ 3. Usual performance is at a satisfactory level.
- ☐ 4. Shows somewhat limited capabilities in this aspect of the job.
- ☐ 5. Has demonstrated very definite limitations in this respect.

P. How acceptable is his work? (Considering all the factors already rated, what is his all-around ability to do assembly jobs?)

- ☐ 1. Capable of outstanding performance in this respect.
- ☐ 2. Performs at an above average level.
- ☐ 3. Usual performance is at a satisfactory level.
- ☐ 4. Shows somewhat limited capabilities in this aspect of the job.
- ☐ 5. Has demonstrated very definite limitations in this respect.

FACT SHEET

Job Title: Machinery Erector (engine & turbine; mach. mfg.) 638.281-014

Job Summary: Erects and tests machinery and heavy equipment such as hydraulic turbines, turbine wheels, jaw stone crushers, industrial surface condensers, flaking machines, valves, and mine hoists, according to blueprints and specifications, using handtools, power tools, heating equipment, and measuring instruments.

Work Performed: Worker assembles, erects, and tests machinery and heavy equipment according to blueprints and specifications, using handtools, heating equipment, and measuring instruments. Worker positions steel beams to support the bedplates of machines and equipment, levels bedplate, and establishes centerline, using straightedge, levels, and transit. Signals ELECTRIC-BRIDGE-or GANTRY-CRANE OPERATOR to lower basic assembly unit, such as shaft, shaft casing, frame, or housing unit, to bedplate and aligns unit to centerline. Lays out mounting holes, using measuring instruments and drills holes with power drill. Bolts parts, such as side and deck plates, jaw plates, and journals, to basic assembly unit. Attaches moving parts and subassemblies, such as shafts, rollers, flywheels, runners (water wheels), valves, gates, bearings, and bearing supports, to basic assembly unit, using handtools and power tools. Shrink-fits bushings, sleeves, rings, liners, gears, and wheels to specified items, using portable gas heating equipment. Sets specified clearances between moving and stationary parts by inserting shims, adjusting tension on nuts and bolts, or positioning parts, using handtools and measuring instruments. Connects power unit to machine or steam piping to equipment, and tests unit to evaluate its mechanical operation. Replaces defective parts of machine or adjusts clearances and alignment of moving parts. Dismantles machinery and equipment for shipment to installation site.

Effectiveness of Norms: Only 64% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the S-445 norms, 76% would have been good workers. 36% of the non-test-selected workers used for this study were poor workers; if the workers had been test-selected with the S-445 norms, only 24% would have been poor workers.

Applicability of S-445 Norms: The aptitude test battery is applicable to jobs which include a majority of the job duties described above.

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